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SUBJECT: AAP-1/AAP-2 Simplified Mission
Description - Case 620**DATE:** March 11, 1968**FROM:** D. S. LopezMEMORANDUM FOR FILE

This memorandum provides a simplified description of the AAP-1/AAP-2 mission with special emphasis on the pressurization of the cluster and activation of the Orbital Workshop (OWS). OWS passivation is not covered in detail. Much of the data used in preparing this memorandum was obtained from an MSFC report titled "AAP-2 Design Reference Flight Sequence" dated November 27, 1967.

The sequence of operations especially in the pressurization and in the activation phases, has been revised several times and will undoubtedly change again. The hardware design, in most cases, is not sequence dependent and will not require redesign when the sequence is revised. The following sequence is current and should be representative of the final plan.

Day 1

The AAP-2 space vehicle is launched and the S-IVB stage, to be used as the OWS, is placed in a 205 by 230 nm elliptical orbit which is later circularized at 230 nm.

The stage passivation process is initiated immediately after J-2 engine shutdown. The process consists of dumping the LOX and LH₂ residuals through the J-2 (the ΔV produced by this propellant dumping is used to circularize the orbit at 230 nm) engine and then venting the propellant tanks and other pressure vessels down to a predetermined safe pressure. Passivation is normally completed within 7.5 hours after orbital insertion. When passivation is complete the LH₂ tank pressure is 10^{-3} psia, the secondary non-propulsive vent (NPV) valve (1, Figure 1) is locked open, and the meteoroid shield and the solar arrays are deployed. The stage control helium bottle is not vented until Day 2 as it is used to close the NPV valve prior to OWS pressurization.

At launch the Multiple Docking Adapter (MDA) and the Airlock Module (AM) STS, forward and airlock sections (Figure 2) are pressurized with GN₂ to slightly above ambient pressure. The

AM aft section vent to vacuum valve (2, Figure 1) is open at launch to insure a positive pressure differential between the OWS and the AM aft section for structural reasons. During the boost phase the GN_2 is vented through the MDA NPV valve (3, Figure 1) until the pressure reaches about 4.5 psia. The NPV valve is closed at this time and remains closed until a check of the pressure integrity of the MDA and AM is made from the ground. The vent is then reopened and remains open until the pressure reaches approximately 1.5 psia.

Day 2

First eight hours - The AAP-1 space vehicle is launched approximately 24 hours after the AAP-2 launch. The CSM is placed into orbit, rendezvouses with the AAP-2 cluster and docks to the axial port of the MDA. Docking is completed about five hours after launch. After docking, the tunnel volume between the CM hatch and the MDA hatch is pressurized to five psia with O_2 through the equalization valve (4, Figure 1) in the CM hatch. The crew removes and stows the CM hatch, checks the security of the docking latches, removes and stows the docking probe and drogue and connects the CM/MDA electrical, voice and data umbilical. The crew then connects the O_2/N_2 internal umbilical (5, Figure 1) in the tunnel and opens the O_2 valve (6, Figure 1) to start MDA/AM pressurization with O_2 through the orifice in the umbilical valve in the MDA (7, Figure 1) which was open to the MDA at launch. The MDA and the AM STS, forward and airlock sections (Figure 2) are brought to a total pressure of 5 psia (approximately 3.5 psia O_2 , 1.5 psia N_2) in about one hour. The O_2 valve (6, Figure 1) is then closed. The forward airlock hatch (Figure 2) is closed at launch but its equalization valve (8, Figure 1) is open at launch to permit pressurization of the airlock section.

Two crewmen, in vented pressure suits for thermal protection, attach their 60 ft. umbilicals to the CM crew station and don Portable Life Support Systems (PLSS) preparatory to entering the MDA. The PLSS's are necessary at this time as the CM crew station does not supply water for temperature control of the pressure suits. The MDA hatch equalization valve (9, Figure 1) is opened. The valve flow indicator is checked to determine that the CM and MDA pressures are equal,

the MDA lights are turned on, then the MDA hatch is removed and stowed.

Second eight hours - The two crew members enter the MDA and turn on the fans, heaters and instrumentation. They then enter the STS section of the AM and activate the instrumentation, fans and the ECS compressors. After checking the passivation status of the OWS at the STS Display and Control (D&C) panel and verifying that the OWS pressure is not greater than 10^{-3} psia, the secondary NPV valve (2, Figure 1) is closed and the stage control He bottle is vented. The astronauts then blow open the pyro valves (10, Figure 1) in the OWS pressurization line preparatory to pressurizing the OWS. One astronaut then obtains one portable potable water bottle from its stowed position in the MDA, carries it into the CM, fills it, returns it to the MDA and restows it. There are two of these bottles in the MDA. They are filled periodically throughout the mission and used to supply water when required in the AM, MDA and OWS.

The third astronaut, in the CM, activates the CM O_2/N_2 regulation system and opens the N_2 supply valve (11, Figure 1) to begin pressurization of the OWS. He then operates the nephelometer used in Experiment T003 (In-flight Nephelometer) which measures the concentration of dust particles in the spacecraft atmosphere.

The two astronauts return to the CM and connect the flexible duct from the AM ECS to the CM attach point. This duct provides conditioned atmosphere from the AM ECS to the CM. The crew then has a 1.5 hour period for eating and rest and relaxation (R&R) followed by an eight hour sleep period. Just prior to the sleep period they verify that the OWS has reached the desired N_2 pressure (approximately 1.3 psia), close the N_2 supply valve (11, Figure 1) and open the O_2 supply valve (6, Figure 1) to continue OWS pressurization. (About 5 hours are required for the N_2 pressurization phase.)

Third eight hours - The first five hours are in the sleep period followed by one hour to eat. Two crewmen go to the STS control panel and turn on the lights and suit coolant pumps, then service the ECS heat exchanger with water from the portable bottle. They disconnect their 60' umbilicals from the CM crew station and connect them to the STS IVA

station (12, Figure 1). They remove their PLSS's as the STS station provides suit thermal control. They open the forward airlock hatch (Figure 2), enter the airlock and close the aft AM section vent-to-vacuum valve (2, Figure 1), verify that OWS total pressure is 5 psia, close the OWS O₂ pressurization valve (6, Figure 1) and open the airlock/OWS equalization valve (13, Figure 1). (About 11 hours are required for the O₂ pressurization phase.) They then open the aft AM section/airlock section equalization valve (14, Figure 1).

In the CM the third crewman turns off the atmosphere conditioning function of the CM ECS. The CM ECS continues to supply makeup oxygen and nitrogen throughout the mission but the atmospheric conditioning is done by the AM ECS.

Day 3

The two astronauts open the aft airlock hatch (Figure 2) and turn on the aft AM section lights. The OWS entrance hatch equalization valve (15, Figure 1) is opened, pressure is equalized and the OWS entrance hatch is opened and latched in the stowed position. The OWS entry lights on the hatch are turned on. The astronauts then connect the AM ECS duct to the OWS manifold and turn on the duct fan in the AM aft section. They enter the OWS and inspect it for damage. This completes a 3 hour work period. They then return to the CM for a three hour period for eating and R&R.

After R&R, the two crewmen return to the OWS with the OWS D&C panel which they install. They then return to the MDA and obtain the OWS lights which they install in the OWS. They then activate the OWS D&C panel electrically and turn on the OWS lights. They return to the MDA for the OWS free volume fans which they carry to the OWS and stow. This completes a 4 hour work period. They return to the CM for 1 hour to eat.

After eating, they obtain the thermal plenum fan/heaters from the MDA, carry them to and install them in the OWS. They then install the previously stowed free volume fans and turn them on. They return to the MDA, obtain the Thermal Liner Heater & Control Module, carry it to the OWS, install it and turn it on. This completes a 4 hour work period. They return to the CM for 1 hour to eat and 8 hours of sleep.* During this day's operations, the third astronaut, in the CM performs the daily CM tasks consisting of monitoring the

*All lights are turned off in the OWS, AM and MDA during crew periods in the CM.

ECS systems panel, checking and correcting the cluster attitude, maintaining voice communications with the ground and performing the daily in-flight nephelometer experiment.

Day 4

After using the first hour to eat, two astronauts enter the MDA and transfer the package containing the OWS penetration plugs and seals from the MDA to the OWS. During the next 2-1/2 hours they install propellant utilization probe pad, inspect the thermal sleeves, install the penetration seals and plugs and inspect the crew quarters area. (While one astronaut is performing these tasks, he is photographed by the other for Experiment M055 - Time and Motion Studies). They then return to the STS where they verify the OWS activation and checkout systems on the STS D&C panel. This completes a 6 hour work period and they return to the CM for a 3 hour period of R&R.

The next 5 hours are used in transferring the water tank, personal hygiene packages and other equipment from the MDA to the waste management area. At the completion of this work period the two astronauts return to the CM where they spend 1 hour in eating followed by an 8 hour sleep period.

The third astronaut eats during the first hour. He then spends 5 hours performing his normal CM monitoring and control duties. He then sleeps for 4 hours, spends 3 hours in R&R, sleeps for 4 more hours then eats for 1 hour. Cluster temperatures are now suitable for Constant Wear Garment (CWG) operations by all astronauts. He then enters the MDA in his CWG and transfers the M056 (Non-Gravimetric Mass Measurement) experiment package to the waste management area. He then spends about 4-1/2 hours partially installing the waste management system. This completes a 6 hour work period and he returns to the CM.

Day 5

Two crewmen spend the first hour eating then enter the MDA wearing CWGs. They spend the next 6 hours transferring 7 operational food packages and 3 experimental food packages to the food management area in the OWS. They then return to

the CM for a 3 hour R&R period. This is followed by a 5 hour work period during which they transfer 6 personal hygiene packages to the food management area. At the conclusion of this work period they return to the CM where they eat for one hour followed by an 8 hour sleep period.

The third crewman eats during the first hour, sleeps for the next 8 hours, then eats again for 1 hour. During the next 5 hours he performs CM monitoring and control duties. After this he has a 3 hour R&R period followed by a 6 hour work period in which he transfers 2 food preparation trays, a water tank and water heater to the food management area in the OWS. He then spends about 3-1/2 hours completing the installation of the waste management system. This completes a 6 hour work period and he returns to the CM.

Day 6

The two crewmen eat during the first hour then enter the MDA and transfer the miscellaneous storage module to the OWS. While in the OWS they complete the installation of the food management area. They then spend about 4 hours transferring 6 equipment storage packages from the MDA to the crew quarters in the OWS. This completes a 6 hour work period and they return to the CM for a 3 hour R&R period. After this, they return to the MDA and transfer packages containing crew quarters equipment in the OWS. They return to the MDA and transfer 2 NASA sleep packages to the NASA bedroom in the crew quarters. They spend the next 3-1/2 hours setting up the NASA bedroom. This completes a 5 hour work period. They return to the CM for a one hour period for eating followed by an 8 hour sleep period.

The third crewman eats during the first hour, sleeps for the next 8 hours, then eats during the next hour. During the next 5 hours he performs CM monitoring and control duties. This is followed by a 3 hour R&R period and a 6 hour work period. During the work period he transfers experiment packages from the MDA to the crew quarters (1 M058, 1 M051, 4 M050/M018 and 3 M053). At the end of this work period he returns to the CM.

The cycle of activities performed by the astronauts during days 5 and 6 is the standard work/sleep cycle for AAP-2 (Figure 3) and is used from day 5 through day 28 with the

exception of the rest days. The three astronauts exchange jobs periodically during the mission so that the duties of the third crewman are performed by each of the astronauts.

Day 7

During the first work period the two crewmen enter the MDA and transfer 5 M058 experiment packages to the OWS work area. They return to the MDA and transfer 2 D019 (Suit Donning and Sleep Station Evaluation) experiment packages to the DOD bedroom in the crew quarters. They spend the next hour setting up the DOD bedroom.* The second work period is reserved for unscheduled maintenance.

The third crewman performs his normal duties during his first work period. The second work period is spent in the OWS performing sample drying and preserving samples for future drying for experiment M052 (Bone and Muscle Changes). At the conclusion of this work period he returns to the CM.

Day 8

Both Day 8 and Day 22 are set aside for rest and relaxation.

Day 9 through Day 26

This period is used to perform the corollary experiments of the mission. The crew daily activities follow the same schedule throughout the period (Figure 3). The work periods for the two crewmen are spent in conducting the experiments and in performing scheduled maintenance.

M051 (Cardiovascular Function Assessment) is performed on each astronaut every third day. M018 (Vectorcardiogram) is performed four times on each astronaut in conjunction with M050 (Metabolic Activity). M058 (Human Mass Measurement) is performed on each astronaut during the second meal each day. M052 (Bone and Muscle Changes) is performed on each astronaut with each meal. M056 (Non-Gravimetric Mass Measurement) is performed once each day. M053 (Human Vestibular Function) is performed five times by each astronaut. Fifteen additional, non-medically oriented, experiments are performed during the mission.

*The disparity in time required to set up the NASA bedroom (3-1/2 hours) compared to the DOD bedroom (1 hour) is due to the fact that the NASA bedroom design has not been completed and a very conservative estimate of the time required has been made.

The third crewman spends his first work period in CM monitoring and control tasks including the nephelometer experiment. In most cases the second work period is spent in sample drying for M052 and in M056.

Day 27

This is the start of the OWS deactivation sequence. All three crewmen follow the standard work/sleep cycle (Figure 3) on Day 27 and Day 28.

During their first work period the two crewmen collect items to be returned to Earth and stow them in the CM. They then return to the OWS where they package the dry waste material (non-biological) and stow it in the STS. They return to the OWS where they close and seal the vacuum valve. They empty the two H₂O bottles into the AM ECS condensate line. The empty bottles are then placed in their storage position in the MDA.

In the second work period they turn off the compressors in the aft AM atmosphere control function of the ECS. They then enter the OWS and prepare the food and waste management areas for storage. They disconnect the duct from the AM ECS to the OWS and stow it in the aft AM section. They remove the solid traps and LiOH canisters from the aft AM ECS system, place them in bags and stow them in the STS. They go back to the CM then return to the STS section in vented pressure suits with their 60 ft. umbilicals connected to the CM crew station. They turn off the compressors in the STS atmospheric control function (mol sieve) of the ECS. They remove and bag the solid traps and charcoal bed from the mol sieve and stow them in the STS. They then turn on the heaters in the mol sieve vacuum vent (non-propulsive) and open the vent starting the vacuum purge of the silica gel and zeolite in the mol sieve to prepare it for the next mission. They then return to the CM.

The third crewman activates the atmosphere control function of the CM ECS as that function is no longer performed by the AM ECS.* He also performs his normal CM monitoring duties.

Day 28

The two crewmen, in vented pressure suits go to the STS and transfer the previously stowed packages (dry waste, charcoal beds, etc.) to the airlock. They connect their 60 ft. umbilicals to the airlock crew station (16, Figure 1) and prepare for extravehicular activity (EVA). They depressurize the

*The CM ECS is activated prior to deactivation of the AM ECS.

airlock, open the EVA hatch and spend about two hours of EVA securing the packages to the aft AM truss. They then close the EVA hatch, repressurize the airlock, open the airlock forward and aft hatches and return to the CM.

During their second work period, the two crewmen in vented suits, enter the STS and connect their 60 ft. umbilicals to the STS crew station (12, Figure 1). They enter the OWS and remove the cap from the OWS initial pressurization line and the seal from the secondary NPV valve (1, Figure 1). They then turn off all fans and heaters. (If the fans are to be stored in the MDA they will be carried there at this time). They return to the aft section of the AM, turn off all electrical power to the OWS, and turn off the aft AM duct fan. They enter the STS and cap the aft AM ducts, disconnect their umbilicals and connect them to the CM crew station. They then return to the STS and open the valve which drains the water from the suit cooling module, H₂O and ECS condensate system into space. They then close the aft hatch of the airlock (Figure 2) and open the OWS NPV valve (1, Figure 1) from the control station in the AM to start OWS depressurization. They then return to the CM.

The third crewman terminates the O₂ supply to the STS and airlock crew stations (12, 16 Figure 1). He performs his CM control and monitoring tasks and assists in deactivation as required.

Day 29

The two crewmen eat during the first hour then enter the STS in vented suits with their umbilicals connected to the CM crew station. They terminate the vacuum purge of the mol sieve, and turn off the STS lights and fans, and the instrumentation not required in storage. They then enter the MDA where they turn off fans, lights and instrumentation not required in storage. They remove the MDA duct from the CM and stow it in the MDA. They remove the MDA hatch from its stowed position, enter the MDA tunnel and reinstall the hatch. They terminate the electrical power supply to the MDA and disconnect the electrical, voice, data and O₂/N₂ umbilicals in the MDA tunnel (5, Figure 1). They reinstall the probe and drogue and unlock the docking latches. They then install the CM hatch and initiate the depressurization

of the MDA via the Digital Command System. (The pressure to which the MDA will be depressurized has not been determined.) This completes a 4-1/2 hour work period. They eat for one hour and return to work. The cluster is placed in the gravity gradient orientation and the solar panels are oriented in the storage position.

The third crewman, who ate during the first hour then slept for eight hours, begins his work period and all three crewmen work together. They connect their umbilicals and pressurize their suits. They terminate operation of the O_2/N_2 regulation system, open the CM hatch equalization valve (4, Figure 1) and depressurize the CM and tunnel. This is done to remove residual N_2 from the CM atmosphere. The equalization valve is closed and the CM is repressurized to 5 psia with O_2 .

They then separate from the cluster, re-enter and return to a water landing on Earth.

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Attachments
Figures 1, 2 and 3

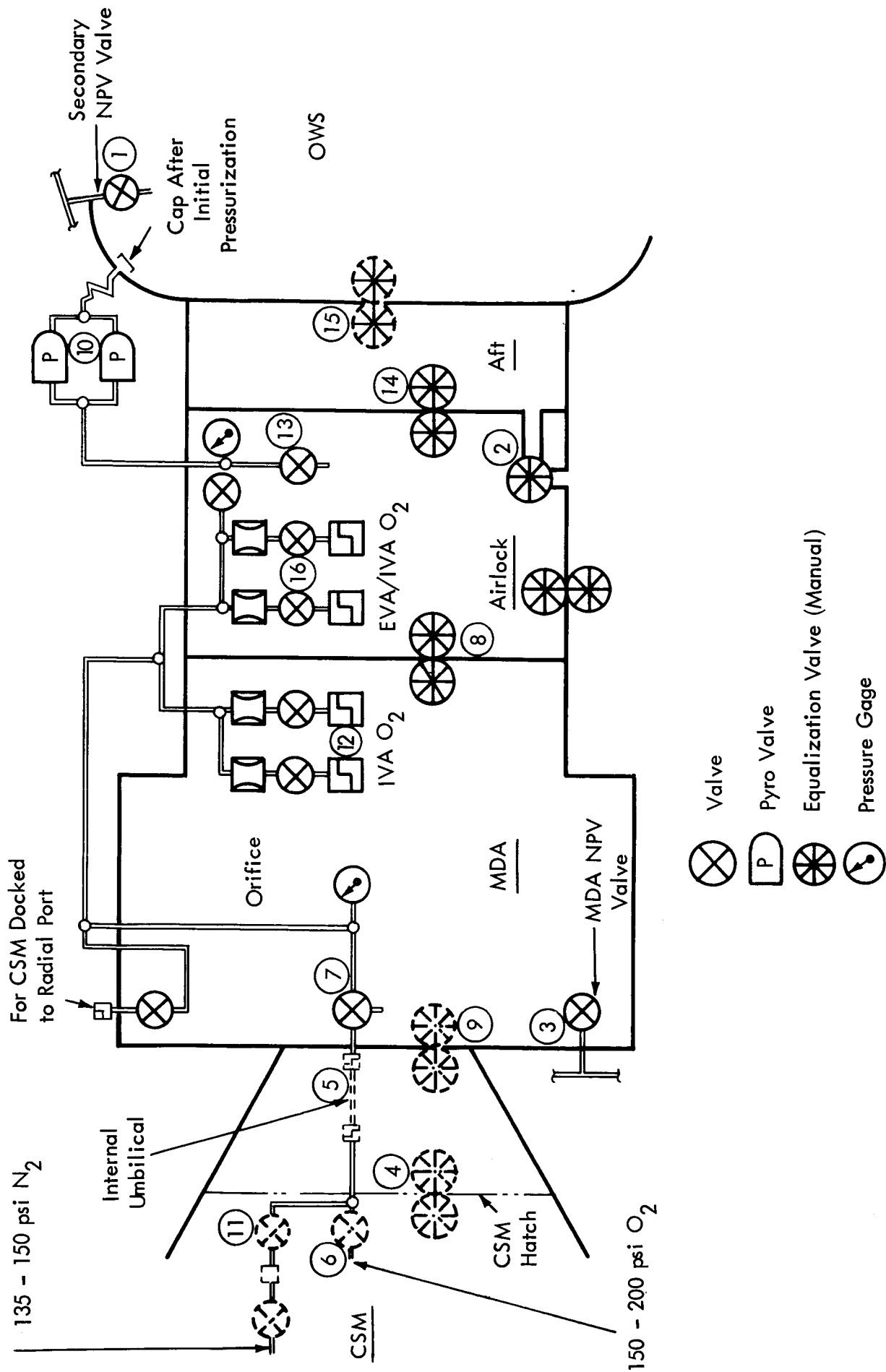


Figure 1. Pressurization and Gas Distribution System

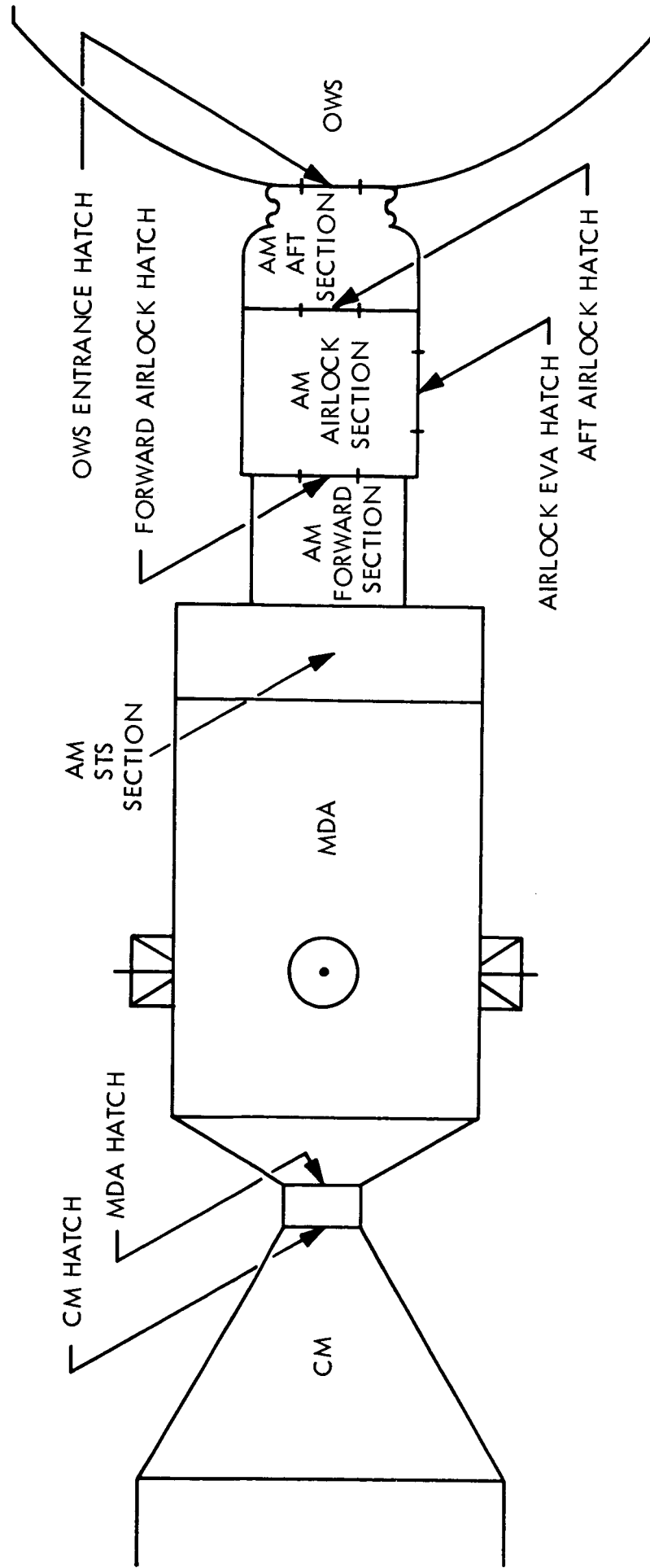


FIGURE 2. AAP-2 DOCKED CONFIGURATION

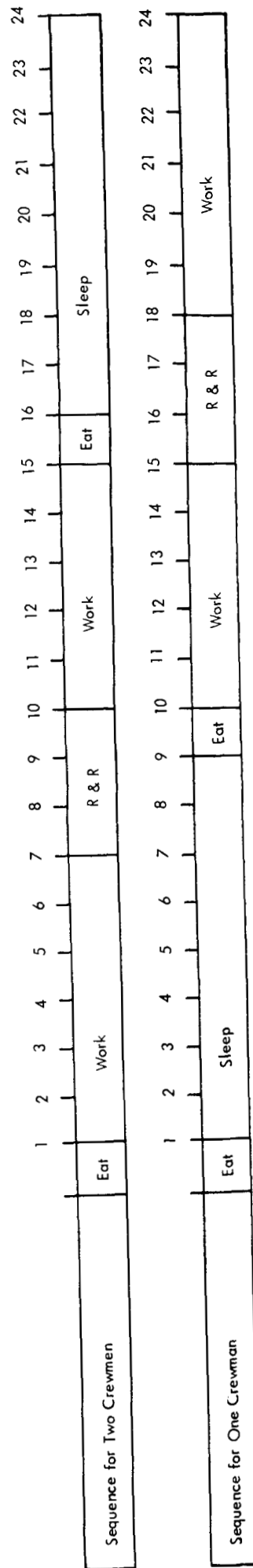


Figure 3. Standard Work/Sleep Cycle